PROTOPERIDINIUM PARTHENOPES SP. NOV. (DINOPHYCEAE), AN INTRIGUING DINOFLAGELLATE FROM THE GULF OF NAPLES

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ABSTRACT. – A new *Protoperidinium* species is described from coastal waters of the Gulf of Naples. *Protoperidinium parthenopes* shows a plate formula of Po, X, 4', 3a, 7'', 4C, 6S, 5''' and 2'''' which is typical for the genus. It is characterized by a peculiar cingular plate pattern, mainly due to the width of the plate 1C which cannot be considered as a transitional (T) plate. Plate 2C is also very wide, connecting to plate 3C in the dorsal part of the cell. The shape and position of the three intercalary plates is another distinctive feature for the species. The relationship with other congeneric species and the position within the genus are discussed.

RÉSUMÉ. – On décrit une nouvelle espèce de *Protoperidinium* récoltée dans les eaux côtières du Golfe de Naples. *Protoperidinium parthenopes* montre une formule épithécale de Po, X, 4', 3a, 7'', 4C, 6S, 5''', 2'''', typique du genre. L'espèce présente un modèle particulier des plaques cingulaires, caractérisé par l'ampleur de la plaque 1C, qui ne peut pas être considérée comme une plaque transitionelle (T). La plaque 2C aussi est très large et se joint avec la plaque 3C dans la partie dorsale du cingulum. Un autre caractère distinctif de l'espèce est la forme et la position des trois plaques intercalaires. On discute les relations avec les autres espèces du même genre et la position dans le genre.

KEY WORDS : Phytoplankton, Dinoflagellates, *Protoperidinium*, *Protoperidinium parthenopes* sp. nov.

INTRODUCTION

A new small dinoflagellate showing a plate formula corresponding to the genus *Protoperidinium* Bergh was found in surface waters of the inner Gulf of Naples.

The genus *Protoperidinium* includes marine peridiniales which are characterized by a typical plate formula of Po, X, 4', 2-3a, 7''(6''), 4C, 6-7S, 5''', 2''''. Most of the species had been formerly described as *Peridinium* Ehrenberg species and successively transferred to *Protoperidinium* on the basis of the number and pattern of cingular and sulcal plates (Balech, 1974). As pointed out by

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Source : MNHN, Paris

many authors (Abé, 1936; Balech, 1980) these plates, which are directly related with the flagella, show a restricted range of variability within the genus as compared to other thecal elements and constitute a reliable character to be used in taxonomy of peridiniales.

The genus groups about 250 species showing a great variation in size, body shape, appendages (horns, spines) and thecal plate ornamentation. As for plate number and pattern, the hypotheca is rather conservative within the genus (with the exception of *Protoperidinium unipes* (Balech) Balech which shows a single antapical plate). By contrast, the epitheca is much more variable, showing variations mainly in the number and shape of the intercalary plates and the shape and relations of the first apical plate.

In the past, many attempts have been made to arrange *Protoperidinium* species into groups of different taxonomical rank based on morphological (Gran, 1902; Paulsen, 1908; Broch, 1910) or structural characters (Jørgensen, 1912; Paulsen, 1931; Balech, 1974) of the theca. This has been complicated by the high variability even within the single species (Diwald, 1940; for a review, see also Netzel & Dürr, 1984). At present, a widely accepted subdivision is that proposed by Balech (1974), who distinguished three subgenera based on characteristics of the epithecal plate pattern, namely the number of intercalary and precingular plates. A different subdivision of the genus was proposed by Abé (1936, 1981), who stressed the taxonomical importance and the higher intraspecific stability of the ventral part of the cell, particularly the sulcal area.

MATERIAL AND METHODS

This study is based on surface samples collected with both a Niskin bottle and 40 μm mesh net two miles offshore from Naples city (40° 48.5'N, 14° 15.0'E). The samples were collected on July 1, 1986.

Samples were fixed in $CaCO_3$ neutralized formaldehyde to a final 1.5% concentration and observed in the light microscope. For plate pattern analysis, a few specimens were isolated on a slide, rinsed with distilled water and treated with concentrated sodium hypochlorite solution. The separation of the plates was obtained with gentle pressure.

For observation with SEM, formol fixed material was rinsed with tap and distilled water, dehydrated in ethanol series, critical point dried and coated with gold.

DIAGNOSIS

Phylum : Pyrrophyta Pascher
Ordo : Peridiniales Haeckel
Familia : Peridiniaceae Ehrenberg
Genus : *Protoperidinium* Bergh

Source : MNHN, Paris

Protoperidinium parthenopes Zingone et Montresor sp. nov.

Cellula globosa, ventraliter parum compressa, sine cornibus et spinis, cum epithecae culmine acuto; 30.0-38.8 µm longa, 26.0-35 µm lata. Theca subtilis cum poris et tuberibus dispersis etiam in cinguli sulcique laminis.

Formula laminarum : Po, X, 4', 3a, 7", 4C, 6S, 5"', 2''''.

Lamella apicalis in epithecae medio est; lamina X ventraliter oblique ad dextram partem se extendit. Lamina 1' rhombi inaequalis forma. Laminae 2' et 4' quasi aequales et convenienter dispositae. Lamina 3' quadrilatera 2a et 3a finitima. Lamina 1a pentagoni forma, 2a, 2', 1", 2" et 3" finitima. Lamina 2a sexangula forma, 1a, 3a, 3", 4", 2' et 3' finitima. Lamina 3a sexangula forma, 2a, 4", 5", 6", 3' et 4' finitima est. Cingulum cavum est, cum limbis angustis, parum ascendens. Prima lamina cingularis tantum longa quantum prima lamina postcingularis est. Lamina 2C est maxime longa ex laminis cingularibus et se committit laminae 3C in parte dorsuali cellulae, iuxta suturam inter 3"' et 4"'. Sutura inter laminas 3C et 4C cum satura inter 4"' et 5"' coniuncta est. Sulcus satis amplus est, se extendit ad culmen ipothecae et e sex laminibus constat. Lamina S. a. posterius firmo angulo terminatur qui in laminae S.d. ala se abdit. Lamina S. d. longa et convexa est et alam habet iuxta suum leavum marginem. Lamina S.s. concava est. Inter S.s. et S.d. duae laminae minores (S.m. et S.p.a.) sunt. Lamina S.p., 1"' et 5"' finitima, amplior est, posterius acuta, cum cavo et firmo margine in parte finitima laminae S.s. In hypotheca lamina 5"' amplior et altior 1"' est.

Species planctonica marina.
Locus typicus : aquae maritimae litorales Neapolis sinus.
Holotypus : figurae inter verba 3-6.

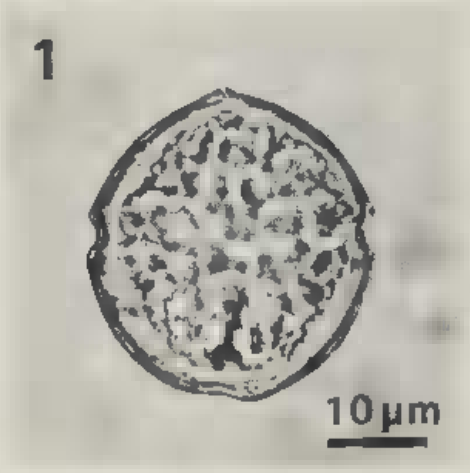


Fig. 1 – *Protoperidinium parthenopes*, light micrograph. Formol fixed specimen.

Source : MNHN, Paris

OBSERVATIONS

The body is globular and ventrally flattened, without horns or spines and with a pointed apex and more rounded antapex (Figs. 1-6). The cell length and width range from 30.0 to 38.8 μm and from 26.0 to 35.0 μm, respectively.

The theca is very thin and shows small pores and protuberances connected by a very faint reticulation (Fig. 3-6). Pores are almost regularly aligned along the thecal plate margins, whereas they are less numerous and irregularly scattered in the central part of the plates. Protuberances are more evenly distributed, at times contiguous with pores, at times isolated. A row of pores is visible on the cingular plates, in proximity to the borders of the postcingular plates (Figs. 2e, 3, 5). Pores are also scattered along the margins of the sulcal plates. The plate margins show conspicuous intercalary bands with slight transversal striations (Figs. 4, 6).

The plate formula is : Po, X, 4', 3a, 7'', 4C, 6S, 5''', 2''''.

The apical pore complex, surrounded by the elevated rims of the neighbouring plates, is located in the centre of the epitheca and extends ventrally and obliquely to the right (Figs. 2c, 4). The pore is teardrop in shape, with elevated margins. The narrow ventral plate is shorter than the pore plate and shows an oblique ventral margin.

Plate 1' is quadrilateral, with a truncate and oblique posterior end, and shows a typical ortho-arrangement (Figs. 2a, 2c, 3, 4). It is markedly asymmetrical and shifted to the right. Plates 2' and 4' are nearly equal in size and symmetric. Plate 3' has four major edges. The dorsal ones, rather convex, are in contact with plates 2a and 3a (Figs. 2c, 4). Plate 3' shares no borders with plate 1a. The latter plate, pentagonal in shape, is shifted to the ventral part of the cell and borders with 2', 2a and the first-three precingular plates. Plate 2a is irregularly hexagonal and elongated antero-posteriorly (Figs. 2b, 2c, 4, 5). It borders only two precingular plates, 3'' and 4'', and the second and third apical plates, as well as the other intercalary plates. Plate 3a borders 2a, 4'', 5'', 6'', 3' and 4'.

The cingulum is excavated (cavozone) and slightly ascending (Figs. 2a, 2e, 3). The cingular lists, formed mainly by the precingular and postcingular plate margins, are very reduced. The first cingular plate is wide, attaining the same width as the first postcingular plate. 2C is the widest of the cingulum, connecting to 3C in the dorsal part of the cell, slightly before or in correspondence with the suture between 3''' and 4''' (Figs. 2b, 5). Plate 3C extends nearly to the ventral part of the cell, at the level of the suture between 4''' and 5'''. 4C is as wide as plate 5''' (Figs. 2a, 6).

The sulcal area, consisting of 6 plates, is rather wide and reaches the antapex (Figs. 2a, 2e, 3, 6). S.a. indents the epitheca with its anterior end, bordering plates 1', 1'' and, with only few exceptions, 7''. It ends posteriorly with a reinforced corner which borders the flagellar pore and is hidden by the wing of plate S.d. Plate S.d., which is long and convex, bears a wing extending along approximately 3/4 of its left margin. Plate S.s. is as long as plate 1'''; it is con-

Source : MNHN, Paris

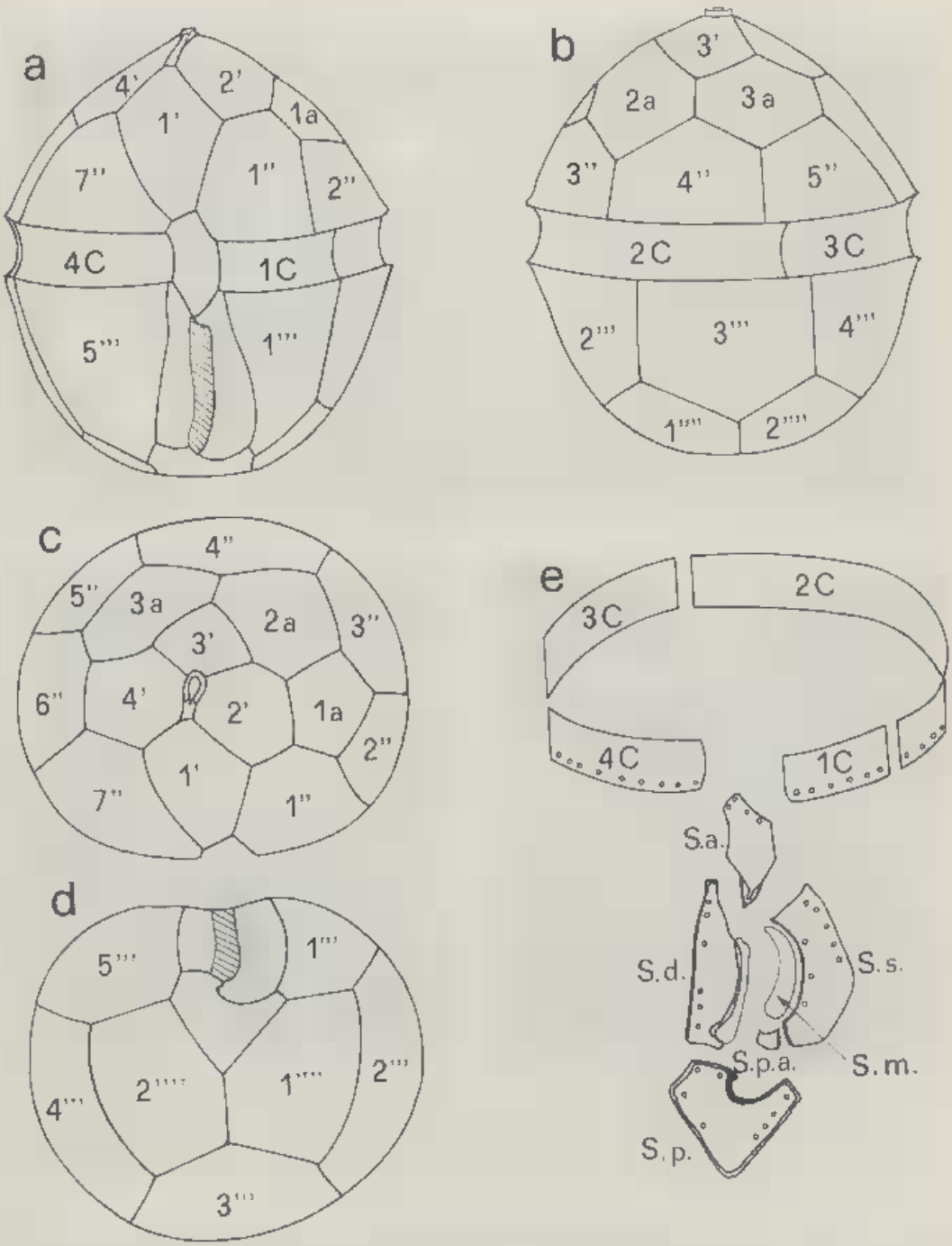
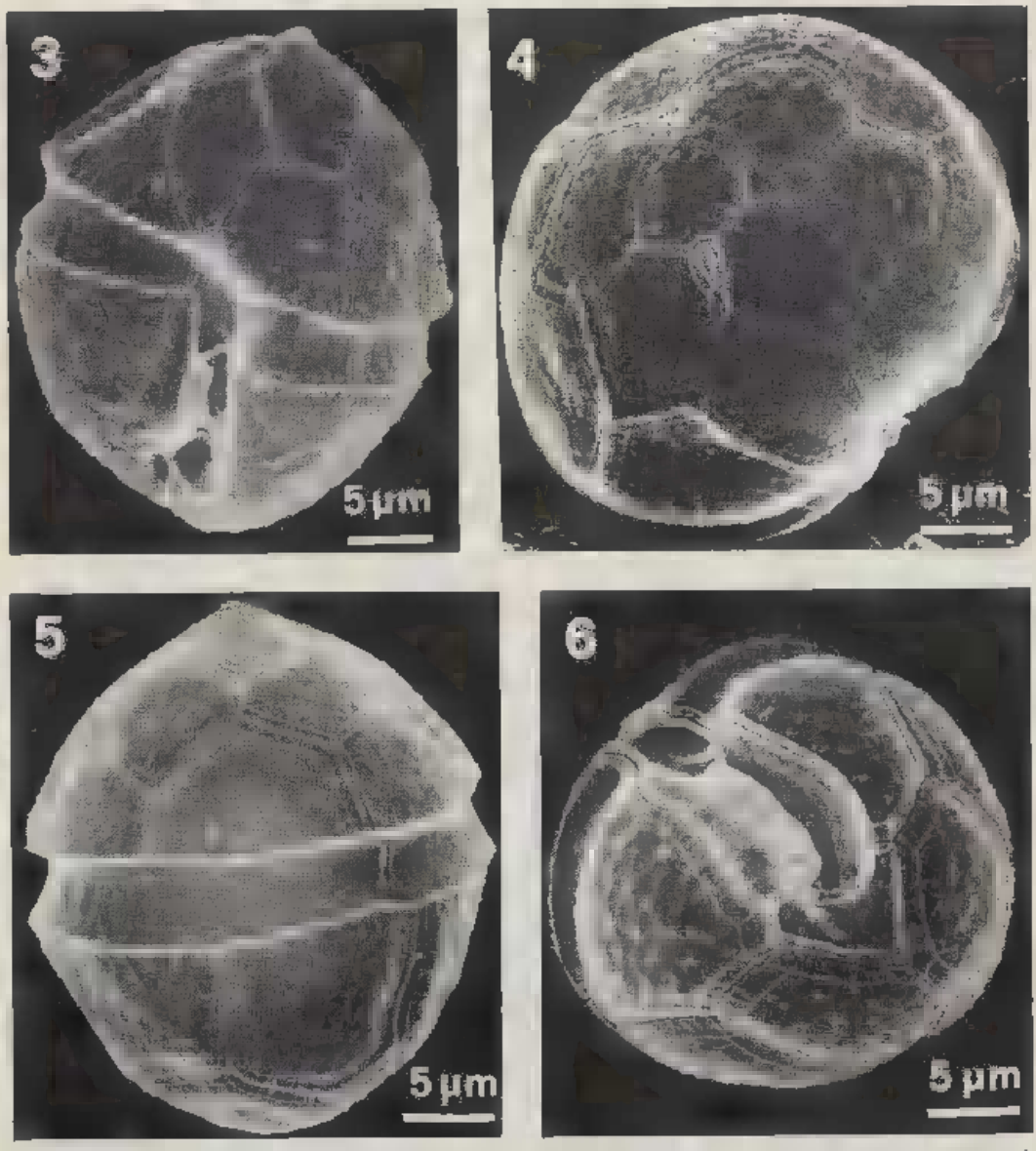


Fig. 2 – *Protoperidinium parthenopes*, schematic drawings. Ventral (a), dorsal (b) view of theca; apical view of epitheca (c); antapical view of hypotheca (d); cingular and sulcal plates (e).

Source : MNHN, Paris



Figs. 3-6 – *Protoperidinium parthenopes*, scanning electron micrographs. Fig. 3. Ventral view. Note the width of 1C plate. Fig. 4. Apical view of epitheca. Note the peculiar arrangement of the three intercalary plates. Fig. 5. Dorsal view. Note the suture between 2C and 3C plates on the dorsal part of the cingulum. Fig. 6. Ventral antapical view.

cave and with a very narrow list bordering its right margin. Between the latter two plates, a long and narrow S.m. plate and, posteriorly, a very small S.p.a. plate are present. S.p. is rather wide, pointed posteriorly, with short and quasi-symmetric arms in contact with plates 1''' and 5'''. Its anterior margin is notched and more reinforced along its border with plate S.s.

Source : MNHN, Paris

In the hypotheca, plate 5''' is very wide and due to the cingular displacement, higher than plate 1''' (Figs. 3, 6).

Apart from the lack of contact which was at times found between plates S.a. and 7'', no significant variation in plate shape and pattern was noted in the observed specimens.

Protoperidinium parthenopes was found in surface waters of the inner Gulf of Naples on July 1, 1986, at a fixed station which has been sampled bi-weekly as of 1984 (ses Scotto di Carlo *et al.*, 1985, for details of sampling site and data collections). Temperature values of 23.6°C and salinity of 37.2 ‰ were recorded at the time of sampling. The species attained a density of 2.4×10^3 cells l^{-1}, constituting a minor part (0.02 %) of the phytoplankton population (12.7×10^6 cells l^{-1}) which was dominated by small diatoms (55 %) and phytoflagellates (33 %).

The species is dedicated to Parthenope, one of the sirens who tried to lure the mythical greek hero Ulysses by their song. Unsuccessful in her attempt, she stranded onto the Neapolitan coast. The ancient name of Naples during the Greek period was derived from her name.

DISCUSSION

Protoperidinium parthenopes differs from all other congeneric species for the peculiar arrangement of the intercalary plates and cingular series. The species raises many interesting questions concerning its position within the genus.

According to the subdivision of the genus proposed by Balech (1974), *P. parthenopes* is to be attributed to the subgenus *Protoperidinium* (Gran) Balech, due to the presence of three intercalary plates. However, plates 2a and 3a are symmetrically arranged with respect to plate 3' which is quadrangular and plate 2a is in touch with 2'. This pattern corresponds to the one showed for the intercalary series by congeneric species possessing only two intercalary plates and therefore grouped in the suborder *Archaeperidinium* (Jørgensen) Balech. Moreover, plate 1a, which is markedly shifted ventrally, borders onto plate 1'' with its ventral margin and is not connected with plate 3'. This arrangement is unique for the genus, since no other *Protoperidinium* species has a suture between 2a and 2'. In addition, even though 2a plate is hexagonal, it is in touch with only two precingular plates (3'' and 4'') as in the other «penta» species, thus differing from all other «hexa» *Protoperidinium*.

The most distinctive feature for *P. parthenopes* concerns the relative proportions of the cingular plates. Most *Protoperidinium* species possess a very narrow first cingular plate which is considered «transitional» (T plate) between the sulcal and cingular series. Generally, the second and fourth cingular plate are also rather narrow, whereas 3C is very broad and constitutes the major part of the cingulum. As a rule, the cingulum is not interrupted in the dorsal part of the cell. On the contrary, *P. parthenopes* shows a wide 1C plate which cannot be

Source : MNHN, Paris

considered as a transitional plate. Moreover, 2C is also wide, connecting to the relatively narrow 3C plate in the dorsal part of the cell.

A somewhat wider 1C plate is present in some *Protoperidinium* species as *P. asymmetricum* Balech, *P. monovelum* (Abé) Balech and *Peridinium fusiforme* Abé (to be transferred to *Protoperidinium* together with other species published by the author in 1981), but this feature is never so pronounced as in *P. parthenopes*. Abé (1981) grouped these species, together with *P. mutsuense* (Abé) Balech and *P. minutum* (Kofoid) Loeblich III, in the group *Monovela* Abé with which *P. parthenopes* shows some affinities. The group, belonging in Abé's classification to the subgenus *Veroperidinium* Paulsen, is in fact characterized by ▪ globular body shape, asymmetrical apical pore complex and first apical plate, and poorly excavated sulcal area which widens posteriorly. Species which indifferently show two or three intercalary plates are found within the group. In fact, the author attributed ▪ relative importance to this series of plates which shows ▪ certain degree of intraspecific variability both in shape and number.

A cingular structure characterized by the absence of a true T plate is a common feature for the closely related freshwater species grouped together with a few marine species in the genus *Peridinium* which is characterized by the presence of 5 or 6 cingular plates (Bourrelly, 1968). In this respect, *P. parthenopes* could be considered rather primitive within the genus since it maintains a relict feature of the freshwater species. This may also be confirmed due to its affinity with the group *Monovela* which has been considered closely related to freshwater species and scarcely evolved within the genus (Abé, 1981).

Another peculiarity for *P. parthenopes* is the pore pattern on the cingular plates. Unlike other congeneric species where pore are irregularly arranged in the central part of the cingular plates (Balech, 1974), a row of pores along the posterior margin of these plates is characteristic for the species. Unfortunately, information is scarce (Andreis *et al.*, 1982; Dodge, 1983; Dodge & Saunders, 1985) and does not allow for comparison with other genera.

Indelicato & Loeblich III (1986) have recently drawn much attention to differences in the position of the sutures between the cingular plates and their relationship with postcingular plate sutures. These authors have proposed a reconsideration of the systematics of some peridiniales based upon this character. Were their proposal to be accepted, *P. parthenopes* would be transferred to a new genus. At present, the species' characteristics seem hardly sufficient to establish ▪ separate genus. In fact, apart from previously mentioned peculiarities, the species here described shows a plate pattern and sulcal arrangement typical for the genus *Protoperidinium*.

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Source : MNHN Paris

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Source : MNHN, Paris